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Analysis of Capital Investment in Industrial Robot: Case X

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Abstract

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The aim of this research-based thesis is to perform an analysis of a capital investment in an industrial robot for a case company. The company X is a start-up based in Estonia. It produces heating, ventilation, and air conditioning (HVAC) modules for Finnish construction companies. The purpose of this study is to assist the case company with the decision regarding an investment in an industrial robot for the automation one of the production processes. Although this study was performed for the case company, it can be useful for manufacturers who are considering automating their production with robots.

The theoretical framework of this thesis provides theories on robots in manufacturing, capital investments and analysis methods used in capital budgeting and theory on investment decision.

The empirical research was conducted in the form of a face-to-face interview and a desktop research. Qualitative analysis methods were applied for the analysis of the collected data. Therefore, the phenomenon of analysis of capital investments in the industrial robot at the case company is described through capital budgeting, payback, accounting rate of return (ARR), net present value (NPV) and cost-volume-profit (CVP) analysis methods.

The findings show that the acquisition of the industrial robot will positively affect the case company's performance, and therefore can be undertaken. However, it is recommended to carefully choose the right moment for the acquisition of the robot.

Keywords
Capital Investment Analysis, Capital Budgeting, Investment in Robot, Investment Decision, CVP Analysis, Payback, ARR, NPV

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1 Introduction

In this chapter the reader will be introduced to the case company and background of this thesis project as well as the purpose of this thesis, research and investigative questions, demarcation, benefits, and main concepts.

1.1 Case Company and Background

The name of the company X is not disclosed due to a sensitive commercial information used in this thesis. When refer to the company X, the following terms are used: “case company”, “commissioning company”, “commissioning party”, “the company” and similar.

The case company belongs to the manufacturing sector of the economy and operates in the construction industry. It is a start-up established in November 2016 in Estonia and it operates in two countries: Estonia and Finland. The headquarter and the production plant are located in Estonia, sales and marketing are in Finland. The company employs 10 people. In 2018 the case company had sales revenue slightly less than one million euros. The company’s customers are big Finnish construction firms.

Case company produces heating, ventilation, and air conditioning (HVAC) modules for construction work. These elements simplify and accelerate process of pipes installation and can be utilized both in new buildings and for renovation work. (Company X representative 14 October 2019.)

Case company’s vision is to have a mainly automatized production by 2019. However, its manufacture is still completely manual and using labor for all production processes. One of the production processes (cutting) generates a lot of dust, requires lifting of heavy sheets and, thus is harmful for the employees. Therefore, the company’s management intend to automate this process in the first place through the utilization of the industrial robot. Besides the company’s management believing that it will improve the employees’ working condition, the use of the robot will enable to better product quality. (Company X representative 14 October 2019.)

The company has contacted one of the European manufacturers of industrial robots and, as a result, have on hand a project for the robot, designed specifically for the case company’s production needs (Company X representative 14 October 2019).
Even though the firm is aiming to obtain one of the European grants which covers up to 50 percent of capital expenditure, the investment is significant for the commissioning party

and the investment decision will have a substantial impact on the case company's future. Therefore, this thesis work aims to help the case company in the investment decision-making.

1.2 Research Question and Investigative Questions

The main goal of this thesis is to analyse an investment in an industrial robot and to assist the case company in an investment decision and, therefore, will be research oriented.
The outcomes of the thesis for the commissioning company will be the following:
- under what conditions should the case company invest in the industrial robot.
The results will provide the company's management with valuable information regarding investment in the industrial robot.
Therefore, the research question (RQ) of this thesis can be worded as: **Under what conditions is capital investment in the industrial robot viable at the case company?**

For the purpose of answering the RQ, the following investigative questions (IQ) were determined:

IQ 1. What is the current performance at the case company?
IQ 2. What are the benefits and drawbacks of the acquisition of the robot at the case company?
IQ 3. How would the investment in the industrial robot affect the case company's performance?
IQ 4. What investment decision can be made based on the results from IQs 1-3?

Table 1 below presents the theoretical framework, research methods and results chapters for each investigative question.

Table 1. Overlay matrix

Investigative Question	Theoretical Framework	Research Methods	Results (chapter)
Q 1. What is the current performance at the case company?	Contribution margin Breakeven point	Qualitative research Desktop research	Chapter 4.1
IQ 2. What are the benefits and drawbacks of the acquisition of the robot at the case company?	SWOT Analysis	Qualitative research, Desktop research	Chapter 4.2
IQ 3. How would the investment in the industrial robot affect the	Contribution margin Breakeven point (BEP) Cost-volume-profit (CVP) analysis	Desktop research	Chapter 4.3

case company's performance?			
IQ 4. What investment decision can be made based on the results from IQs 1-3?	Capital investment analysis methods: Payback period Accounting rate of return (ARR) Net present value (NPV)	Desktop research	Chapter 5.1

1.1 Demarcation

The thesis topic is analysis of capital investment in industrial robot; therefore, this research will be focused on the capital investment analysis at the case company. This study will be limited to a secondary sector of economy and for the construction industry solely.

Besides, this thesis project will be limited to the investments in industrial robot and not any other types of investments.

Finally, the scope of this thesis does not cover the question of how and where to obtain the needed finance for undertaking the investment as well as the ethical issues of potential staff reduction as a result of the robot employment.

1.2 International Aspect

In accordance with Haaga-Helia GLOBBA thesis project requirements, this topic contains an international aspect. Firstly, the case company's business is international, and it operates in two countries: Estonia and Finland. Secondly, the robot considered for the acquisition is produced by an Italian manufacturer and, in case of undertaking the investment, will be delivered to the case company manufacturing facility in Estonia.

And finally, robotization of a production process is generally an international phenomenon which makes the manufacturing process safer and easier for the employees. Moreover, Davis (2015, 66) advocates that robots cut production costs, reduce waste, and minimize lead time, which should make it attractive for acquiring by companies across the globe.

1.3 Benefits

This thesis can benefit different stakeholders including the case company, company's employees, B2B customers, manufacturing sector of the economy, other finance students and the author.

Firstly, the outcome of this thesis will be essential for the company since it is a start-up and the considered investment is significant for the commissioning party. The decision whether to undertake the investment or not can play a crucial role in the future of the company.

Secondly, the company's employees will benefit by gaining a safer and healthier place of work in case the investment is undertaken.

Thirdly, case company's customers can receive better quality product in a shorter period.

And finally, the author will revise her knowledge on capital investment and gain an expertise in particularly capital investment analysis which should be beneficial for her future career.

1.4 Risk Analysis

The main risk identified is that the case company can go bankrupt. Although this risk is not manageable, it has low level of probability to arise any time soon (Company X representative 14 October 2019) and, therefore, there is no need to abandon the thesis.

1.5 Key Concepts

The purpose of this chapter is to provide a mini dictionary of the key concepts, which will be utilised in this thesis project, for the reader not familiar with the topic and the author's field of study – Financial Management.

Term **industrial robot** "as defined by ISO 8373:2012 (IFR 2016): an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications".

Bodie, Kane & Marcus (2013, 2) state that **investment** is the present state of money or other resources expecting to obtain future benefits.

Capital budgeting – is the process of assessing an investment in long-term asset that the company intends to undertake (Davis & Davis 2011).

Cash flow – amount of cash a company receives and pays out (Stittle & Wearing 2008, 153).

Payback period – “the amount of time until the cash flows from a project offsets the initial investment” (Berk, DeMarzo & Harford 2019, 264).

Miller-Nobles, Mattison & Matsumura (2019, 602) describe **accounting rate of return** as “a capital investment analysis method that measures the profitability of an investment”.

Net present value (NPV) - “the difference between the present value of a project’s or investment’s benefits and the present value of its costs” (Berk at al. 2019, 258).

2 Investment Analysis

The objective of this chapter is to build a theory framework which the author can use in her research. The author will explain key concepts and methods of investment analysis process. The author will examine the connection between the investment in the robot and a firm's performance.

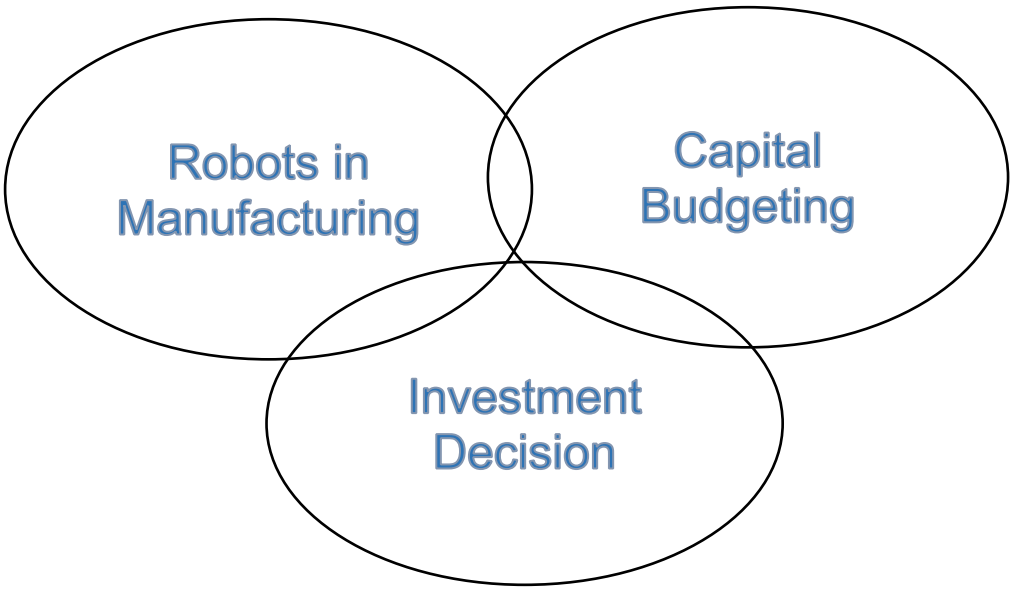

Figure 1. Theoretical Framework Structure

2.1 Robots in Manufacturing

According to the World Robotics report (IFR 2019) there are number of huge challenges the global manufacturing industry is facing. Among them are lack of resources and skilled workforce, fast changing consumer trends, demand for local manufacture, and aging society. Flexible industrial robot-based automation brings the solution to all these challenges. Since 2010 demand for industrial robots has increased dramatically due to the continuous trend towards automation and constant technical innovations in industrial robots. Installation of robots in 2018 was 422 000 units which is growth of six percent compared to the previous year. IFR (2019) has forecasted an average growth of twelve percent per year from 2020 to 2022.

Maw (2018) claims that with the growing speed, power, and precision of industrial robotics, manufacturers who do not invest in robotics today are missing out on enormous potential for efficiency, profitability, and growth.

Marr (2017) points out that experts typically believe that robots will take over the dirty, dull, and dangerous work, known as 3 Ds of robotization. And a fourth D stands for dear or expensive tasks that robots will perform as well.

Moreover, robots can help in solving workforce shortage. Even if the production process does not require skilled labor, staffing can be challenging. For instance, if volume of production highly varies from week to week, it is difficult to find workers who can be so flexible in working hours. Or plant can be located in the area where it is challenging to employ workers. Therefore, dull, dirty, dangerous, expensive, or highly precise tasks, which are mentally easy and monotonous but dangerous or physically demanding are the best target for automation. (Maw 2018.)

Tilley (2017) mentions that robotization can achieve four key objectives: costs reduction, enhancing quality, better worker safety, and increasing flexibility. However, the automation should be reasonable, therefore it is necessary to define how automation can bring improvements and show how these improvements are align with the company's overall strategy. And finally, automation must predict a clear return on investment. RobotWorx (2020) points that typical payback for robot is between 6 – 18 months, depending on the size of initial investment.

2.2 Capital Budgeting

Capital investment refers to investing in **capital assets**, those assets that are expected to create future economic benefits during several years (Davis & Davis 2011). The process of decision making, whether investment in long-term capital assets are worth of undertaking, called **capital budgeting** (Baker & English 2011, 1).

Capital budgeting process include several steps (Braun & Tietz 2015, 719):

Step 1: Identification of potential investment.
Step 2: Future net cash inflows identification.
Step 3: Investment analysis.
Step 4: Capital rationing.
Step 5: Post-audit.

However, due to the limited scope of this thesis project, only the model of cash flow identification and investments analysis methods will be explained in this subchapter in detail.

2.2.1 Cash Flow Identification

To be able to evaluate the investment, a company needs to identify **net cash inflows** – that is cash inflows from the investments less cash outflows (Miller-Nobles & al. 2019, 599).

Miller-Nobles at al. (2019, 598) specify that cash inflows include future cash revenue and cost savings resulting from the investment, and future residual value of the asset, if any. The investment net cash inflow is determined by netting cash inflows against initial investment costs and the investment's future cash outflows such as cash paid for asset maintenance, repair, and replenishment costs. Here it should be mentioned that correct estimation of the future cash inflows is crucial for the best decision making.

2.2.2 Investment Analysis Methods

There are four popular methods used to analyze potential capital investments: payback period, accounting rate of return, net present value, and internal rate of return (IRR). The payback, ARR and NPV the author will examine here.

Miller-Nobles & al. (2019, 599) describe **payback** as "a capital investment analysis method that measures the length of time it takes to recover in net cash inflows, the cost of the initial investment". Estimating the payback differs and depends on whether net cash inflows are equal or different each year.

When net cash inflows are equal each year, payback is estimated as invested amount divided by expected annual net cash inflows. In case of unequal net cash inflows, each net cash inflow should be summarized until the invested amount is recovered. (Miller-Nobles & al. 2019, 600.)

Despite being widely used, payback has been criticized for considering only cash flows that appear during payback period, for not focusing on profitability and for ignoring time value of money. It tells management only how fast it will recover cash spent on capital asset. (Braun & Tietz 2015, 722.)

Therefore, usually payback is used as a tool to recognize and exclude investments that will take too long to recover. Managers rarely use this method solely to make investment decisions. In addition, they use accounting rate of return, net present value, and internal rate of return to support their evaluation. (Miller-Nobles & al. 2019, 602.)

Summarizing, when using the payback method, the following decision rule is in force: the most preferable investments are those with shorter payback period, all else being equal (Braun & Tietz 2015, 723).

Second method of a capital investment analysis is accounting rate of return. Miller-Nobles & al. (2019, 603) describe **accounting rate of return** as the analysis method to assess profitability of an investment. It considers operating income which is based on accrual accounting. To be able to calculate the operating income, all noncash expenses, such as depreciation expense, must be deducted from the net cash inflows. Braun & Tietz (2015, 724) differentiate calculation of ARR of investments with equal and unequal annual net cash inflows. In case of investments with unequal annual net cash inflows, an average annual operating income from the asset should be defined first. It is equal (total of all net cash inflows - total depreciation) / operating life of the asset.

Miller-Nobles & al. (2019, 603) suggest calculating ARR by dividing the average annual operating income from the investment to the average amount invested. The average amount invested is an average between the asset's book value at the beginning of the asset's useful life and at its end. Therefore, the average of the asset without residual value will be equal to its half cost.

However, Braun & Tietz (2015, 724) instead of an average amount invested, for simplicity use as a denominator an initial investment. In case of investments with equal annual net cash inflows, Braun & Tietz (2015, 724) recommend finding the annual operating income by subtracting annual depreciation expense from the annual net cash inflows and then calculate ARR by dividing the annual operating income to the initial investment or average annual investment as suggest Miller-Nobles & al. (2019, 603)

The investment is attractive if the accounting rate of return is equal or higher than the minimum required rate of return. This method measures how the investment will affect profitability. However, it ignores time value of money which is why in addition managers use net present value and /or internal rate of return.

Net present value is a capital investment analysis method that estimates the net difference between the present value of the net cash inflows from the investment and the initial cost of investment (Miller-Nobles & al. 2019, 613).

For understanding the NPV analysis method the **time value of money** concept should be explained here. Time value of money is based on the following main elements: the principal amount (*p*), the number of periods (*n*) and the interest rate (*i*). In case of capital investment, the principal (*p*) is amount of investment. The number of periods (*n*) is the time span from the outset of the investment until completion. The interest rate (*i*) is the annual percentage earned on the investment. (Miller-Nobles & al. 2019, 606.)

Knowing the three abovementioned factors allows to estimate the future or present value of an investment at different point of time. The future value of the investment is sum of principal and the interest earned. The present value of the investment is equal the future value less interest earned and the process of calculating present values is called **discounting future cash flows** (Miller-Nobles & al. 2019, 607-608).

For the purpose of this thesis future cash flows must be discounted to their **present value (PV)** – which is "the value of an investment today" (Miller-Nobles & al. 2019, 607).
Cash inflows can be one-time payments (lump sums) such as, for instance, cash received for a sold asset, or they can be an **annuity** – "a stream of equal cash payments made at equal time intervals" (Miller-Nobles & al. 2019, 606). Braun & Tietz (2015, 729) specify that annuity can be ordinary and annuity due. An **ordinary annuity** is annuity in which the payments take place at the end of each period. In contrast, an **annuity due** is an annuity in which payments take place at the beginning of each period. For purpose of capital budgeting ordinary annuity suites better, and therefore, the author uses it in this thesis. The major difference between identification of present value of a lump sum and identification of present value of annuity is in present value factor used for discounting future cash flows (Miller-Nobles & al. 2019, 608-609).

Miller-Nobles & al. (2019, 613) point out that accurate comparison between two sums of money can be done only by comparing them at the same point in time, at their present value. To calculate the present value of the investment future net cash inflows, they need to be discounted for the minimum required rate of return. This rate is known as **discount rate** and it refers to the interest rate used for the present value calculations. In other words, the discount rate is the interest rate that reduces future amounts to their lesser value in the present.

Miller-Nobles & al. (2019, 613-614) specify that NPV of the investment without residual value is calculated by netting the present value of the investment's net cash inflows against the initial investment cost. However, the method of calculating present values of net cash inflows differs. To compute NPV with unequal periodic net cash inflows each net

cash inflow should be discounted separately as a lump-sum received in different years. Yet, NPV with equal periodic cash inflows must be discounted as an annuity. If an investment has a residual value, the value always should be discounted separately from the net cash inflows, and as a lump-sum, because it will be received only once when asset is sold.

A positive NPV shows that the investment will earn more than the required rate of return. On the contrary, negative NPV means that the project cannot earn the required rate of return. (Miller-Nobles & al. 2019, 614.)

Summarizing, although required calculations for the capital budgeting may seem to be precise, they are based on prediction of an uncertain future. Therefore, decision makers must consider many unknown factors, such as changes in consumers behaviour, rivals, economic and political changes. This is the reason why long-term decisions have higher risk than short-term decisions. (Miller-Nobles & al. 2019, 596.)

2.3 Investment Decision

Relevant information is a key for making business decisions. Costs relevant to a particular decision are called **relevant costs**. On the contrary, **irrelevant costs** are those costs that do not influence the decision. And costs that were incurred in the past and cannot be changed are **sunk costs** and they are always irrelevant for the decisions. (Miller-Nobles & al. 2019, 543.)

Not only **financial, or quantitative information** can be relevant for the decisions. **Nonfinancial, or qualitative factors** likewise important. Both qualitative and quantitative factors of decisions must be considered.

2.3.1 SWOT Analysis

To attain an overall understanding of the company and the main points of the company's business environment SWOT Analysis can be performed. SWOT includes analysis of the company's strength, weaknesses, opportunities, and threats. Strengths and weaknesses are internal. They are the company's internal capabilities and assets, or lack of them, and which add to or diminish the company's value comparatively to competitive forces. Whereas, opportunities and threats are external factors. They are not derived from the

company but arise due to changes in the market or activities of the company's rivals. (Van den Berg & Pietersma 2014.)

Gürel & Tat (2017) note that performing an external analysis helps the company to identify the major opportunities and threats in its competitive environment. Additionally, it evaluates how competition in this environment will likely develop and how it can affect the company. While external analysis concentrates on the environmental opportunities and threats surrounding the company, internal analysis allows the firm to recognize its organizational strengths and weaknesses. Besides, it helps the company to realize which company's internal resources and skills can be used as competitive advantages, and which are less likely to become such. The appropriate strategy can be chosen based on SWOT Analysis.

2.3.2 Cost-Volume-Profit Analysis

Braun & Tietz (2015, 401) describe **cost-volume-profit analysis** as a tool for decision-makers that identifies the relationship between costs, volumes, and the company's profit. CVP analysis is used to determine the sales volume that will be enough to breakeven, or to cover costs. In addition, it is used to calculate the sales volume that will help to earn a target profit. Besides, it is useful in assisting managers being ready to respond to economic changes.

Miller-Nobles & al. (2019, 265) distinguish following components of CVP analysis:

- unit sales price
- sales volume
- variable costs per unit
- fixed costs
- profit/loss.

Additionally, Braun & Tietz (2015, 402) point that for the CVP analysis to be correct, the following assumptions should be met:

- no volume discounts
- costs are linear for the relevant range
- sales mix is constant
- inventory level is not changing.

Miller-Nobles & al. (2019, 256) classify **variable costs** as costs that are changing in direct proportion to a change in volume. In a manufacturing company variable costs may include manufacturing costs such as cost of direct material, and selling and administrative costs,

such as delivery costs. Variable costs are equal to zero if no units were produced. As the reader can see in figure 2 total variable costs increase proportionately to the increasing volume.

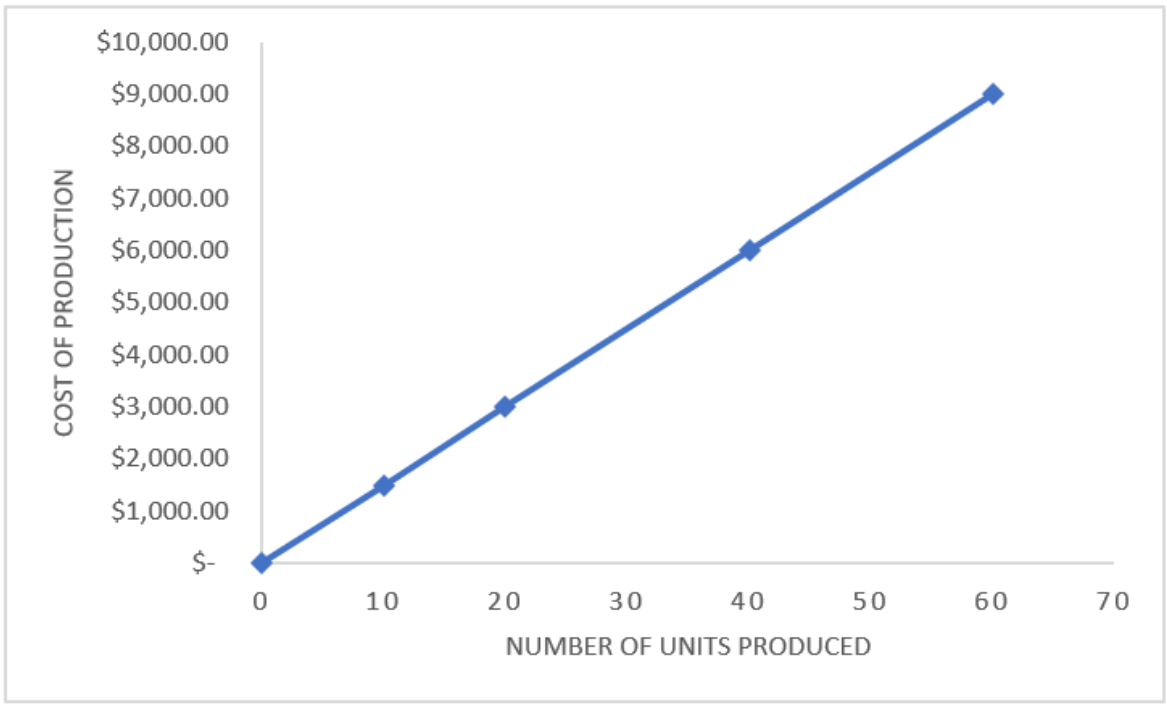

Figure 2. Variable costs (adapted from Miller-Nobles & al. 2019, 257)

Additionally, Miller-Nobles & al. (2019, 257) define **fixed costs** as costs that do not change in total with changes in volume. Usually companies have fixed costs regardless of the number of produced products. Commonly fixed costs can include rent, salaries, property taxes, and straight-line depreciation. Figure 3 shows how the total fixed cost stay constant despite of the change in volume of the produced units.

Miller-Nobles & al. (2019, 258) mention that total fixed costs remain constant, however the fixed costs per unit change inversely when the volume changes. In other words, the higher the volume the lower the fixed costs per unit.

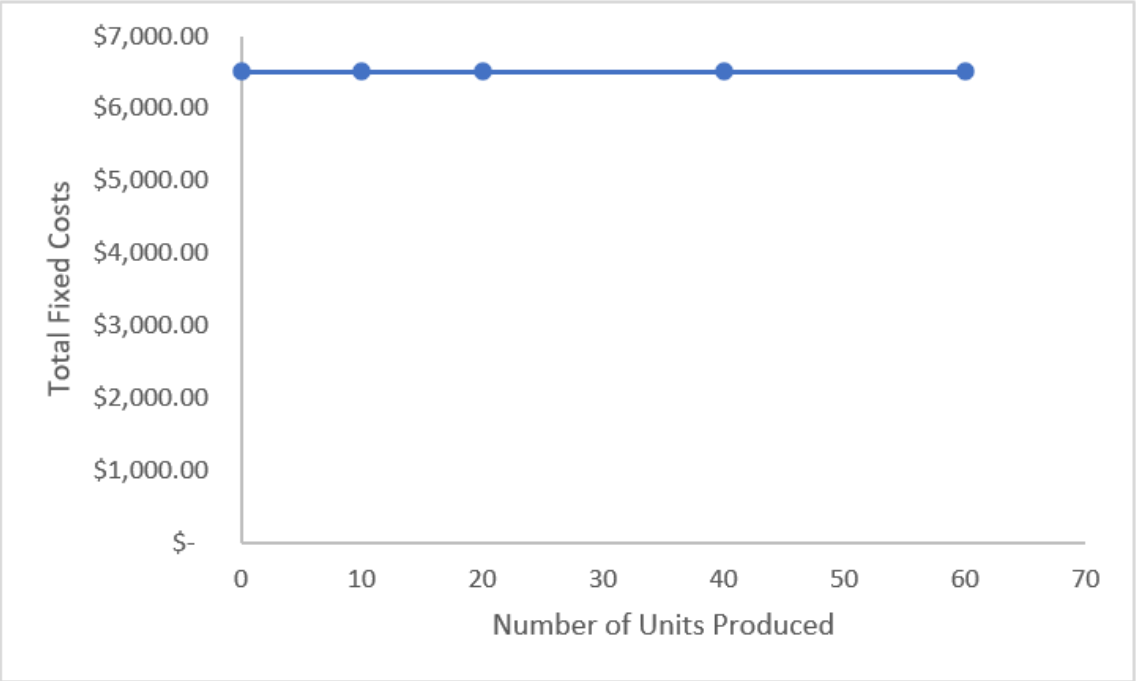

Figure 3. Fixed costs (adapted from Miller-Nobles & al. 2019, 258)

Besides, the total fixed costs are constant within a **relevant range** – that is the range of volume where variable cost per unit and total fixed costs remain constant**.** Therefore, total fixed costs can vary when relevant range changes. (Miller-Nobles & al. 2019, 262.)

Braun & Tietz (2015, 403) define **contribution margin** as a difference between the sales revenue and variable costs. It shows how much revenue is left after covering variable costs for contributing towards covering fixed expenses and gaining profit. Miller-Nobles & al. (2019, 263) add that the contribution margin is often showed as a total, however it can be expressed as a unit amount called unit contribution margin, or as a percentage, or ratio – contribution margin ratio.

Unit contribution margin is an excess of a unit sales price over variable costs per unit. And the ratio of the unit contribution margin to the net sales per unit is a **contribution margin ratio** that can be computed as the contribution margin divided to the net sales revenue. (Braun & Tietz 2015, 403; Miller-Nobles & al. 2019, 264.) The unit contribution margin and the contribution margin ratio are used to determine the breakeven point.

Breakeven point is a sales volume at which operating profit of a company is equal to zero. There are three approaches to estimate the breakeven, however the author will look closely at one – the contribution margin approach. (Miller-Nobles & al. 2019, 265.)

The **contribution margin approach** is a method of computing the required sales in units to breakeven. Breakeven in units shows how many units needs to be sold to cover fixed cost and is calculated as sum of the fixed costs and the target profit divided to the unit contribution margin. (Miller-Nobles & al. 2019, 266; Braun & Tietz 2015, 408.)

However, whether company sells more than one product, breakeven point is computed for the **product mix**. Each product has different sales price and variable costs therefore, each product contributes differently to a company's profit. To calculate the breakeven point for the company it is necessary to determine the weighted-average contribution margin of all the company's products. The percentage of the product in the product mix is computed as number of units of products divided by the total number of units in the product mix. Each percentage is multiplied by unit contribution margin of the respective product. The sum of units' contribution margins in the product mix divided by the total number of units in the mix gives us the weighted-average contribution margin per unit. By dividing the fixed cost by the weighted-average contribution margin per unit we will compute the required sales in units. The breakeven point for each product in the product mix determined by multiplying of the required sales in units to the percentage of each product in the product mix. (Miller-Nobles & al. 2019, 277.)

3 Research Methods

In this chapter the methods chosen to answer the research question and investigative questions, are introduced to the reader. Besides, it is discussed how the research was designed and what were the chosen data collection and analysis methods.

According to Haaga-Helia requirements for the thesis projects, research conducted for this thesis is classified as applied. This means the results obtained from the research can be utilised in real business situations.

Firstly, the type of research chosen for this thesis is an empirical research, therefore the data collection and data analysis will be conducted. Secondly, since in the research the characteristics of a studying phenomenon will be described, the type of the research is to be descriptive. Thirdly, theory is chosen as starting point of the research, which will be used to design the data collection methods, this thesis research type can be described as a theory driven one.

The theories, concepts and models presented in chapter 2 will be applied to the analysis of the collected data. In the case of this thesis project the phenomenon of analysis of capital investment in the industrial robot at the case company will be described through the capital budgeting, payback, ARR, NPV and CVP analysis methods.

Finally, based on the research timeline, the research is a longitudinal one as it contains the assessment of the company's cash flows during the next five years.

3.1 Research Design

Research design is a plan for empirical study that provides the methods for data collection and analysis needed to answer the research question (Ghauri & Grønhaug, 2010, 54). The research methods (Figure 4) consists of four phases. Data collection and data analysis methods chosen for each research phase are presented here with the relations to investigative questions.

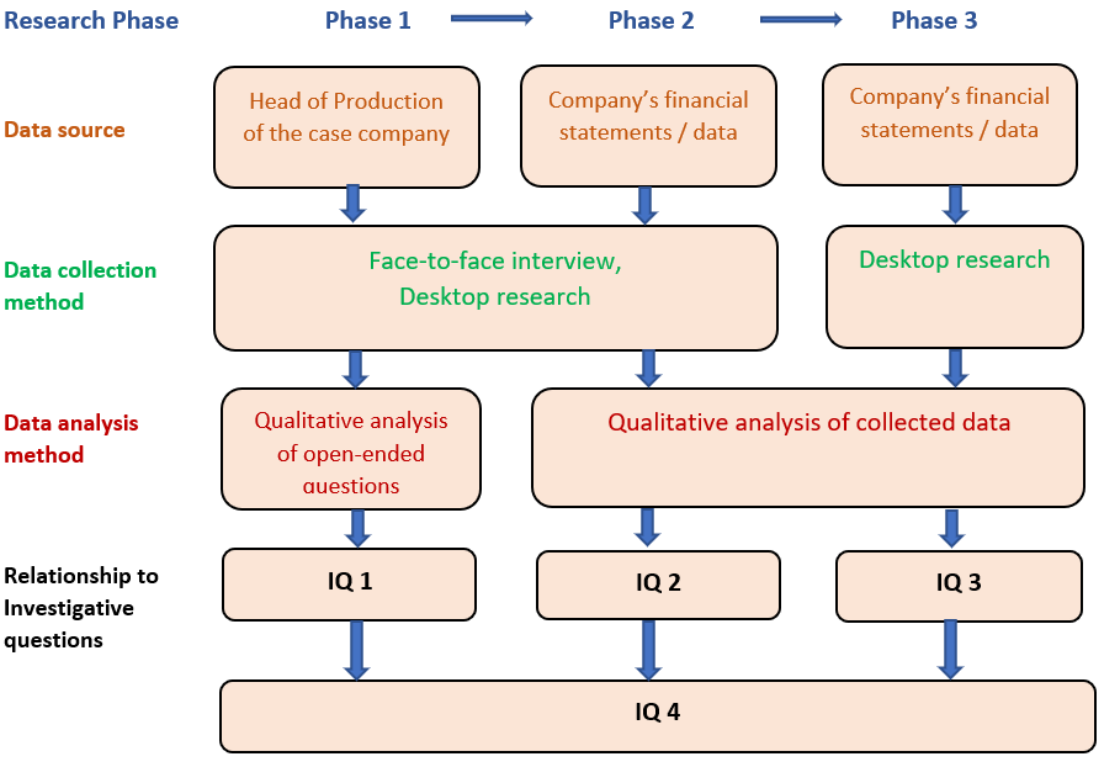

Figure 4. Research methods

3.2 Data Collection and Analysis

To conduct the empirical research, data collection should be performed. For this thesis data collected through primary sources and therefore, data collection methods were chosen accordingly.

Although collected data is primarily quantitative such as prices, costs and volumes, the methods of data collection chosen are qualitative. Qualitative methods were chosen because the objectives of the study demand in-depth comprehension of a phenomenon. It requires to describe what happened in the past to be able to plan for the future. (Ghauri & Grønhaug, 2010, 111.)

The interview and a desktop research to collect data for the phase one and two and a desktop research – to collect data for the phases three are conducted. The author performed face-to-face interview with the commissioning company's representative – Head of Production. For the interview, the author prepared in advance the interview framework that contained open-ended questions to the interviewee. The interview questions were

formed in a way supporting the data collection needed to answer the investigative questions and the research question. The interview questions are presented in appendix 1 of this thesis.

During a desktop research the financial data of the case company primarily was collected through observations of the company's financial statements.

Qualitative data analysis methods are utilized for the further analysis of the collected data. The analysis of open-ended questions was conducted for reviewing of the interview. Furthermore, theoretical concepts and analysis methods, presented in chapter 2, were applied in practice for the analysis of the collected data.

4. Data Analysis

This chapter presents the process of analysis of the collected data by applying the theory from the theoretical framework.

4.1 The Case Company's Current Performance

4.1.1 Production Process

The case company produces duct modules for construction work – HVAC vertical brackets (bracket) (Figure 5). One of the elements of the bracket is concrete fiber sheet (sheet) (Figure 6). It is manufactured during cutting process of production and can be sold as a separate product. Production (cutting) of the sheets is currently manual; it generates a lot of dust and requires lifting heavy parts.

At the factory currently the unit of production is a bracket and a sheet. Direct labor consists of four employees working in the plant full time. Production of one bracket requires 3.5 hours. This process includes cutting of the concrete sheet, which takes 0.5 hours and assembling the bracket which requires 3 hours. Currently one worker can produce (cut and assemble) two brackets per workday. However, cutting of one sheet requires 0.25 hours of simultaneous work of two employees and for 1 hour they along can produce four sheets. In detail the worktime allocation during a workday among the production processes for the manufacturing of brackets is shown in table 2, and for the production of sheets solely – in table 3. Here it is important to mention that these two processes are mutually exclusive. In other words, a worker's worktime can either be allocated as represented in table 2 or as represented in table 3, but not simultaneously. In case both cutting and assembling could be done simultaneously, 4 workers per day could cut 28 sheets and assembly 4.6 brackets.

Table 2. Allocation of worktime for bracket production

	Worktime			Total
Hours	1	3	3	7
Production process	Cutting	Assembling		Result
Unit of production	sheet	bracket		bracket
Worker 1	4	1	1	2
Worker 2		1	1	2
Worker 3	4	1	1	2
Worker 4		1	1	2
Total		**4**	**4**	**8**

Table 3. Allocation of worktime for cutting sheets

	Worktime	Total
Hours	1	7
Production process	Cutting	Result
Unit of production	sheet	sheet
Employee 1 Employee 2	4	28
Employee 3 Employee 4	4	28
Total	**8**	**56**

The unit variable costs include cost of direct material, direct labor, and delivery expense. In 2019 830 brackets and 786 sheets were produced. Delivery expenses amounted to 22 879 euros and the delivery costs per unit were therefore, calculated as delivery expense per year divided by the total units produced and were equal to 14.16 euros per unit.
Cost of direct material were 625 euros per bracket and 43 euros per sheet.

Although direct labour costs are fixed expense at the case company, for the purpose of this thesis the direct labor costs were considered as variable and direct labor costs per unit were determined.

Direct labor costs per hour were calculated as the total direct labor costs per year divided by the total number of hours spent to produce 830 brackets and 786 sheets. Then to calculate the direct labor costs per unit of bracket, the number of hours spent to produce one bracket were multiplied to the direct labor cost per hour. Similarly, were estimated the direct labor unit costs for production of sheet. Therefore, the unit direct labor costs for production of brackets totaled 84.10 euros and those of sheets – 12.01 euros.
The total unit variable costs amounted 723.26 euros per produced bracket and 69.17 euros per sheet.

Figure 5. Vertical bracket

Figure 6. Concrete fiber sheet

The major amount of fixed costs of the company are formed by the rent and the labor expenses and totaled 353 172.55 euros per year.

With the unit sales price per bracket – 1250 euros and per sheet – 85 euros, unit contribution margin was defined as 526.74 euros and 15.83 euros, respectively. Then breakeven points were calculated for the sales mix 51 percent of brackets and 49 percent of sheets as follows:

- The unit contribution margins of the bracket and the sheet were multiplied by its percentage in the sales mix, respectively.
- The obtained numbers were summarized and divided by the total of sales mix to define a weighted-average contribution margin per unit.
- The yearly fixed expense was divided by the weighted-average contribution margin per unit to find required sales in units.
- The BEP of each product was calculated as the required sales in units multiplied by the percentage in the sales mix and totaled 652 units of brackets and 617 units of sheets.

During the next step, the author determined how many units can be produced by the current number of workers – 4 people. Therefore, full capacity in terms of bracket units totaled 1000 units of brackets assembled and 6100 units of sheets cut per year. Here it should be emphasized that the 6100 units of sheets would contained 1000 units required

for the assembling of brackets therefore, the maximum amount of sheets can be produced and sold as a separate product for the current relevant range is 5100 units.
In detail these amounts were calculated by multiplying the maximum number of units one worker can produce per workday by an average number of workdays per year – 218, which were further multiplied by number of workers - 4. The average number of workdays at the case company was defined as an average amount of workdays in Estonia - 253 days less 28 days of the annual vacation and forecasted 7 days of a sick- or other reason annual leave.

4.1.2 SWOT Analysis

In accordance with the interview (Company X representative 14 October 2019) main points for the SWOT analysis were defined as represented in figure 7.

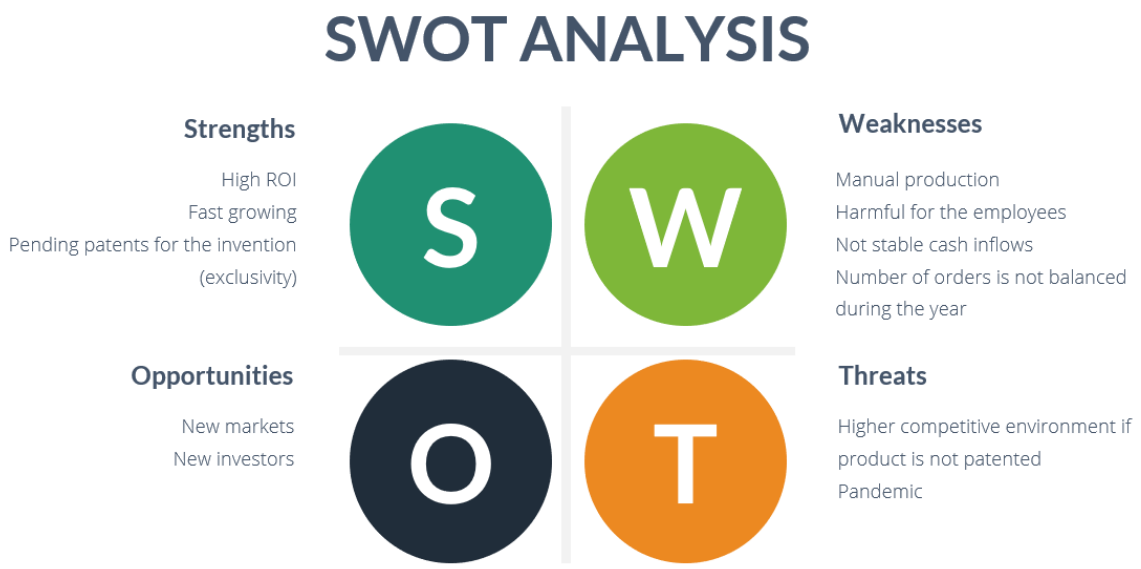

Figure 7. SWOT Analysis of the case company

According to the case company's financial statements, in 2019 it had return on investment ratio (ROI) 59 percent. In 2019 the company's sales revenue increased by 29 percent compared to the previous year. Moreover, operating profit and net profit increased by 96 percent and 107 percent, respectively. Furthermore, sales revenue for the first quarter of 2020 increased by 56 percent compared to the same period of the previous year and operating profit along with the net profit increased by 224 and 465 percent, respectively. Moreover, the company currently has a pending patent for the product it produces and sells which can be considered as one of the major competitive advantages. Therefore, as

the company's strengths, high growth rate, ROI and the exclusivity for production obtained through the pending patent were recognized.

Whereas the company enjoys its strengths, in addition it has several weaknesses. Among them is the production process which is currently completely manual, and the workers do all the measuring, cutting, and assembling by hand with the utilization of small tools. The manual production is less precise, and it is more time consuming compared to the automated one and can be more costly. Besides, it is harmful for the workers and involve great risks of injuries.

The other weakness identified was unbalanced number of orders during the year and as a result unstable cash inflow. Moreover, this impacts the production process significantly in terms of labor. There are four workers at the production site, and sometimes they can be overloaded with the work and must do long hours, whereas other times they have nothing to do, however, they should be paid as they have fixed salaries. Therefore, the automation of the production process is under the company's top priorities.

Among opportunities was acknowledged expanding to the new markets such as Scandinavian countries, UK, Eastern Europe, and Baltic countries. Moreover, it can attract new investors and foster the company's growth and development.

The main company threat is the heavy competitive environment. In case its invention is not patented the company would lose the exclusivity for its product. This could lead to a price war and would need to attempt finding new ways to reduce costs such as acquiring new suppliers, cheaper materials, relocation of production to developing countries and so on. The other threat is epidemic or pandemic which recently happened in the world and completely paralyzed many businesses around the globe.

To sum up, the case company shows preconditions for the further growth and preliminary readiness for acquiring the industrial robot to automate one of the production processes. However, further in-depth analysis of the investment in the industrial robot must be performed. Moreover, it should be taken into consideration that current economic crisis due to the Coronavirus outbreak can have a substantial impact to the company's finance and slow down the company's growth.

4.2 Investment in the Robot: Benefits and Drawbacks

Investment in the robot is not only a capital investment, it is strategical decision. Identification of potential benefits of the robot acquisition is the main task of a decision maker.

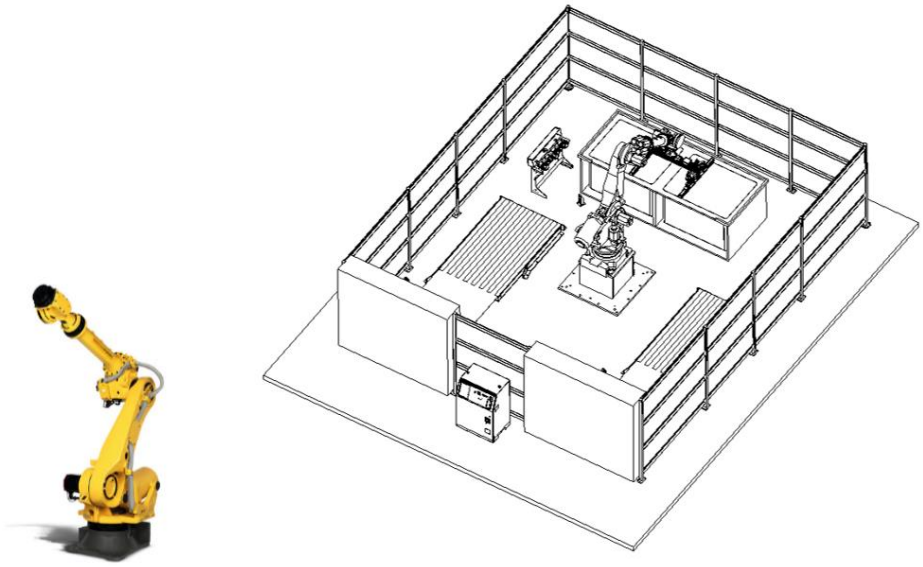

Figure 8. Industrial robot design for the case company (Heikari 17 December 2018)

The following benefits, drawbacks, opportunities, and risks of acquisition of the industrial robot were identified during the interview with the Head of production of the case company (Company X representative 14 October 2019):

Benefits:

- reduction of production costs
- better employees working environment
- improved production quality
- reduced risks of injuries
- possibility of utilizing robot 24/7
- consistency in performing the tasks
- reduced scraps.

Drawbacks:

- high acquisition costs of the robot
- high repair costs.

Opportunities:

- enlargement of production capacity
- possibility for new product development
- possible unit price reduction in case of higher competitive environment.

Risks:

- not enough orders to return the investments
- shortage of educated workforce
- risk of programming mistakes
- risk of a breakdown.

4.3 Utilization of the Robot and Company's Performance

In this subchapter, the author attempts to estimate how the company would perform in case of undertaking the investment. It is assumed that unit sales prices of the company's products remain unchanged during next five years. Similarly, it is assumed that cost of direct material, direct labor and delivery cost will remain the same.

4.3.1 Production Manual vs Robot

After close observation of the production process, its current capacity, and technical characteristics of the industrial robot, it was determined that robotization of the cutting process will enhance the production efficiency.

Firstly, it will reduce the cutting time by 50 percent and therefore, during one workday one robot can produce twice as many sheets as two workers manually. Secondly, it will allow workers to relocate 100 percent of their worktime to the assembling of the brackets and thus, will reduce time for the manufacturing of the bracket and increase the number of produced units per day. Thirdly, the robot will provide an opportunity to produce sheets 24/7, if necessary. And finally, it will enable to perform assembling and cutting simultaneously which will reduce the product lead time and increase production capacity. In table 4 below are represented all the above-mentioned figures.

Table 4. Production manual vs robot

	Manual		**Robot solution**	
	brackets	**sheets**	**brackets**	**sheets**
Hours required for production of one unit	3	0.5	3	0.13
Units assembled by 1 worker per workday	2.3	not applied	2.3	not applied
Units cut by 2 workers per workday	not applied	28	not applied	not applied
Units produced by the robot per workday	not applied	not applied	not applied	64

Production at full capacity by 4 workers, units per year	1003	6104	2006	16192

4.3.2 Budgeted Income Statements

For the purpose of comparing numbers before and after the investment undertaken income statements were budgeted for the sales equal to 2019 – 830 brackets and 786 sheets, and for the forecasted sales both for the manual production (pre-investment) and for the production with the robot solution (after the investment). The sales forecast will be closely looked at later in this subchapter.

Column1	2021	2022	2023	2024	2025
Net Sales Revenue	1,104,310.00 €	1,104,310.00 €	1,104,310.00 €	1,104,310.00 €	1,104,310.00 €
Brackets	1,037,500.00 €	1,037,500.00 €	1,037,500.00 €	1,037,500.00 €	1,037,500.00 €
Sheets	66,810.00 €	66,810.00 €	66,810.00 €	66,810.00 €	66,810.00 €
Variable costs:					
Brackets:					
Manufacturing	588,554.56 €	588,554.56 €	588,554.56 €	588,554.56 €	588,554.56 €
Selling & Administrative	11,750.50 €	11,750.50 €	11,750.50 €	11,750.50 €	11,750.50 €
Sheets:					
Manufacturing	43,241.44 €	43,241.44 €	43,241.44 €	43,241.44 €	43,241.44 €
Selling & Administrative	11,127.59 €	11,127.59 €	11,127.59 €	11,127.59 €	11,127.59 €
Total Variable Costs	654,674.09 €	654,674.09 €	654,674.09 €	654,674.09 €	654,674.09 €
Contribution Margin	449,635.91 €	449,635.91 €	449,635.91 €	449,635.91 €	449,635.91 €
Fixed Costs:					
Manufacturing	55,951.19 €	55,951.19 €	55,951.19 €	55,951.19 €	55,951.19 €
Selling & Administrative	297,221.36 €	297,221.36 €	297,221.36 €	297,221.36 €	297,221.36 €
Total Fixed Costs	353,172.55 €	353,172.55 €	353,172.55 €	353,172.55 €	353,172.55 €
Operating Income/Loss	**96,463.36 €**	**96,463.36 €**	**96,463.36 €**	**96,463.36 €**	**96,463.36 €**

Figure 9. Budgeted income statement – sales equal to 2019 (pre-investment)

For the budgeted income statement after the investment (Figure 10) manufacturing fixed costs increased by 64 percent compared to those before the investment, due to the additional costs of robot utilization and maintenance and an annual robot's depreciation expense.

However, robotization of the cutting process would allow the workers to relocate 100 percent of their worktime for the assembling of brackets and therefore, half of workers would be a sufficient number which will result in decreasing of direct labor costs by 50 percent.

Column1	2021	2022	2023	2024	2025
Net Sales Revenue	1,104,310.00 €	1,104,310.00 €	1,104,310.00 €	1,104,310.00 €	1,104,310.00 €
Brackets	1,037,500.00 €	1,037,500.00 €	1,037,500.00 €	1,037,500.00 €	1,037,500.00 €
Sheets	66,810.00 €	66,810.00 €	66,810.00 €	66,810.00 €	66,810.00 €
Variable costs:					
Brackets:					
Manufacturing	558,374.00 €	558,374.00 €	558,374.00 €	558,374.00 €	558,374.00 €
Selling & Administrative	11,750.50 €	11,750.50 €	11,750.50 €	11,750.50 €	11,750.50 €
Sheets:					
Manufacturing	33,798.00 €	33,798.00 €	33,798.00 €	33,798.00 €	33,798.00 €
Selling & Administrative	11,127.59 €	11,127.59 €	11,127.59 €	11,127.59 €	11,127.59 €
Total Variable Costs	615,050.09 €	615,050.09 €	615,050.09 €	615,050.09 €	615,050.09 €
Contribution Margin	489,259.91 €	489,259.91 €	489,259.91 €	489,259.91 €	489,259.91 €
Fixed Costs:					
Manufacturing	91,791.19 €	91,791.19 €	91,791.19 €	91,791.19 €	91,791.19 €
Selling & Administrative	297,221.36 €	297,221.36 €	297,221.36 €	297,221.36 €	297,221.36 €
Total Fixed Costs	389,012.55 €	389,012.55 €	389,012.55 €	389,012.55 €	389,012.55 €
Operating Income/Loss	**100,247.36 €**	**100,247.36 €**	**100,247.36 €**	**100,247.36 €**	**100,247.36 €**

Figure 10. Budgeted income statement – sales equal to 2019 (after the investment)

As a next step, the author forecasted the sales in terms of units separately for brackets and sheets for the next five years (Figure 11). The sales revenues for the following five years (2021-2025) are forecasted according to the growth rate of the sales revenue for 2019 towards the sales revenue for the first quarter of 2020 which were projected for the rest of the year. The estimated growth rate was 25 percent, however, the growth rate for the forecasted sales was assumed to be 20 percent which was approved by the commissioning party.

Year	2021	2022	2023	2024	2025
Brackets produced per year	1000	1200	1440	1728	2074
Sheets produced per year	950	1140	1368	1642	1970

Figure 11. Forecasted sales

For the budgeting of income statement, the author chose the contribution margin approach therefore, all costs were divided to variable (manufacturing and selling and administrative) and fixed similarly.

Column1	2021	2022	2023	2024	2025
Net Sales Revenue	1,330,750.00 €	1,596,900.00 €	1,916,280.00 €	2,299,536.00 €	2,759,443.20 €
Brackets	1,250,000.00 €	1,500,000.00 €	1,800,000.00 €	2,160,000.00 €	2,592,000.00 €
Sheets	80,750.00 €	96,900.00 €	116,280.00 €	139,536.00 €	167,443.20 €
Variable costs:					
Brackets:					
Manufacturing	709,101.88 €	850,922.26 €	1,021,106.71 €	1,225,328.05 €	1,470,393.66 €
Selling & Administrative	14,157.23 €	16,988.68 €	20,386.42 €	24,463.70 €	29,356.44 €
Sheets:					
Manufacturing	52,263.83 €	62,716.59 €	75,259.91 €	90,311.89 €	108,374.27 €
Selling & Administrative	13,449.37 €	16,139.25 €	19,367.10 €	23,240.52 €	27,888.62 €
Total Variable Costs	788,972.31 €	946,766.78 €	1,136,120.13 €	1,363,344.16 €	1,636,012.99 €
Contribution Margin	541,777.69 €	650,133.22 €	780,159.87 €	936,191.84 €	1,123,430.21 €
Fixed Costs:					
Manufacturing	55,951.19 €	55,951.19 €	55,951.19 €	55,951.19 €	55,951.19 €
Selling & Administrative	297,221.36 €	297,221.36 €	297,221.36 €	297,221.36 €	297,221.36 €
Total Fixed Costs	353,172.55 €	353,172.55 €	353,172.55 €	353,172.55 €	353,172.55 €
Operating Income/Loss	**188,605.14 €**	**296,960.67 €**	**426,987.32 €**	**583,019.29 €**	**770,257.66 €**

Figure 12. Budgeted income statement - forecasted sales (pre-investment)

Due to a low requirement of labor time for loading and unloading the robot with sheets for cutting process (approximately 10 minutes for loading and unloading per 100 sheets), the author decided to not take these costs into consideration as too insignificant. Therefore, there will not be any additional labor costs implied for cutting of sheets with the robot.

Besides, the robot's annual depreciation expense was determined. It was calculated on a straight-line basis with the residual value 32 300 euros which is 20 percent of the robot's cost including cost of additional parts totalled 161 500 euros. As additional fixed costs 10 000 euros annual expense for the robot utilization and maintenance were added as was given by the case company (Company X representative 14 October 2019).

Column1	2021	2022	2023	2024	2025
Net Sales Revenue	1,330,750.00 €	1,596,900.00 €	1,916,280.00 €	2,299,536.00 €	2,759,443.20 €
Brackets	1,250,000.00 €	1,500,000.00 €	1,800,000.00 €	2,160,000.00 €	2,592,000.00 €
Sheets	80,750.00 €	96,900.00 €	116,280.00 €	139,536.00 €	167,443.20 €
Variable costs:					
Brackets:					
Manufacturing	672,739.76 €	807,287.71 €	968,745.25 €	1,162,494.30 €	1,394,993.16 €
Selling & Administrative	14,157.23 €	16,988.68 €	20,386.42 €	24,463.70 €	29,356.44 €
Sheets:					
Manufacturing	40,850.00 €	49,020.00 €	58,824.00 €	70,588.80 €	84,706.56 €
Selling & Administrative	13,449.37 €	16,139.25 €	19,367.10 €	23,240.52 €	27,888.62 €
Total Variable Costs	741,196.37 €	889,435.64 €	1,067,322.77 €	1,280,787.32 €	1,536,944.78 €
Contribution Margin	589,553.63 €	707,464.36 €	848,957.23 €	1,018,748.68 €	1,222,498.42 €
Fixed Costs:					
Manufacturing	91,791.19 €	91,791.19 €	91,791.19 €	91,791.19 €	91,791.19 €
Selling & Administrative	297,221.36 €	297,221.36 €	297,221.36 €	297,221.36 €	297,221.36 €
Total Fixed Costs	389,012.55 €	389,012.55 €	389,012.55 €	389,012.55 €	389,012.55 €
Operating Income/Loss	**200,541.08 €**	**318,451.81 €**	**459,944.68 €**	**629,736.13 €**	**833,485.87 €**

Figure 13. Budgeted income statement - forecasted sales (after the investment)

Summarizing, comparing figures 9 and 10 or figures 12 and 13 respectively, contribution margins are higher after the investment due to a lower direct labor costs which are reduced by utilization of the robot.

However, the budgeted operating incomes do not differ significantly before and after the investment. The reasons behind are an additional annual fixed cost for the robot maintenance 10 000 euros, and 25 840 euros of the robot's annual depreciation expense incurred.

4.3.3 Investment Analysis

For the investment analysis the author has chosen payback, ARR and NPV analysis methods. The main reason is to look at the investment from different angles and to obtain wider perspective. Thus, payback enables the author to estimate when an invested amount will be recovered. At the same time ARR measures profitability of the investment and focuses on the operating income over the entire robot's lifetime. However, neither of these methods consider the time value of money and therefore, NPV method additionally was performed. NPV allows to determine whether the investment will be profitable with consideration of the interest rate over the lifetime of the robot.

Before the investment analysis performed, it is crucial to determine net cash inflows over the entire period of the robot utilization – five years. All the cash inflows generated from the robot were identified as:

- the revenue generated from the sales of sheets
- the direct labor cost savings
- the residual value of the robot.

Among the cash outflows were determined:

- the robot acquisition costs
- the variable manufacturing costs of sheets and its selling and administrative expense
- the additional fixed expense of the robot utilization and maintenance.

The net cash inflows were calculated for each year by netting the cash inflows against the cash outflows. Then all three investment analysis methods were applied to analysing the net cash inflows for the sales equal to 2019, which assumed to generate equal annual payments for five years. And for forecasted sales, which consider to be generating unequal annual net cash inflows during the same period - five years.

Payback of the investment with sales equal to 2019 projected for the following five years were calculated as the annual net cash inflows divided by the initial investment and totalled 4.1 years. In case of the forecasted sales, payback was determined as represented in figure 14.

Net Cash Outflows		Net Cash Inflows	
Year	Amount Invested	Annual	Accumulated
0	172,350.00 €		
1		52,812.75 €	52,812.75 €
2		65,375.30 €	118,188.05 €
3		80,450.36 €	198,638.41 €
4		98,540.43 €	297,178.83 €
5		120,248.52 €	417,427.35 €
5	(Residual value)	32,300.00 €	449,727.35 €

<= Payback Period = 2.7 years

Figure 14. Computing the payback period

As the reader can see in figure 14 the payback falls in between second and third year. On the year two 118 188.05 euros out of 172 350 euros are recovered therefore, 54 161.95 euros are left unrecovered. This amount was divided by the net cash inflow of the year three to determine 0.7 years during which the rest of the investment amount should be recovered. Along with two years it gives the payback 2.7 years.

Accounting rate of return of the investment with equal net cash inflows using an average invested amount was computed as follows:

- Annual operating income is the annual net cash inflow less the annual robot depreciation expense.
- Average amount invested is a sum of the initial investment and the robot residual value divided by two.

ARR estimated as the annual operating income divided by the average amount invested and totalled 16 percent.

The process of computing ARR in case of unequal net cash inflows (for the forecasted sales) was as follows:

- Average annual operating income was calculated as the total net cash inflows excluding the robot's residual value, less the total robot depreciation divided by the robot operating life of five years.
- Average amount invested was computed the same way as in the case of equal net cash inflows.
- ARR was determined as the average annual operating income divided by the average amount invested and resulted in 56 percent.

Net present value for the investment with equal net cash inflows (for the sales equal to 2019) was computed using the following steps:

- Identification of present value of net cash inflows using an ordinary annuity present value factor (PV) of i = 9%, n = 5, which is equal to 3.89, where i is a discount rate which is an average interest rate for the loans in the case company's financing bank (Swedbank 2020), and n is the robot's operating life – five years.
- Computing of present value of the robot's residual value, which was discounted as a single lump-sum with PV factor of i = 9%, n = 5, equalled to 0.65.
- Sum of the present value of the net cash inflows and the present value of the robot's residual value was netted against the initial investment and thus, NPV totalled 12 277,75 euros.

NPV with unequal annual net cash inflows (for the forecasted sales) though was computed in a different way:

- Net cash inflows for each year were discounted as single lump-sums using PV factor of i = 9%, and n = number of each period. Exact PV factors used are represented in figure 15.
- Similarly, the present value of the robot's residual value was determined using PV = 0.65.
- Finally, the sum of the present values of the net cash inflows and the present value of the robot's residual value was netted against the initial investment and therefore, NPV amounted in 162 156.13 euros.

	D	E	F
40		Net Cash Inflows	
41	Year	Annual	PV
42	1	52812.7486757375	=+E42*0.917
43	2	65375.298410885	=+E43*0.842
44	3	80450.3580930621	=+E44*0.772
45	4	98540.4297116745	=+E45*0.708
46	5	120248.515654009	=+E46*0.65

Figure 15. PV factors for discounting net cash inflows

5. Conclusions

In the previous chapter the author presented the analysis of the collected data and the way she applied in practice theories and methods introduced in the theoretical framework. In this chapter all the key findings will be reviewed, and recommendations towards the undertaking of the investment and further research will be given. Besides, reliability and validity of the obtained results along with the author's reflection on learning will be discussed.

5.1 Findings

IQ 1. What is the current performance at the case company?

Minimum required number of workers at the sales equal to 2019 is four people. Besides, number of orders is unbalanced during the year: some periods are overloaded with work, and other periods are quiet. Current breakeven point is 652 units of bracket and 617 units of sheets. Four workers can produce up to 1000 brackets and up to 6100 sheets per one year. Biggest fixed costs are labor costs and rent expense.

IQ 2. What are the benefits and drawbacks of the acquisition of the robot at the case company?

Among the main benefits are:

- reduction of production costs
- better employees working environment
- improved production quality
- reduced risks of injuries
- possibility of utilizing the robot 24/7
- consistency in performing the tasks
- reduced scraps.

Major drawbacks are:

- high acquisition costs
- high cost of repair
- risk of programming mistakes and breakdown.

IQ 3. How would the investment in the industrial robot affect the case company's performance?

As represented in figure 16 the operating incomes with the robot solution do not substantially change considering the sales behave as in 2019.

	2021	2022	2023	2024	2025
Sales equal to 2019	Operating Income/Loss				
Pre-investment	96,463.36 €	96,463.36 €	96,463.36 €	96,463.36 €	96,463.36 €
After the investment	100,247.36 €	100,247.36 €	100,247.36 €	100,247.36 €	100,247.36 €
Difference	3,784.00 €	3,784.00 €	3,784.00 €	3,784.00 €	3,784.00 €
Difference, %	3.9%	3.9%	3.9%	3.9%	3.9%

Figure 16. Operating income comparison for the sales equal to 2019

However, figure 17 shows that in case of 20 percent of sales growth per year the operating income after the investment may increase by more than six percent per year.

	2021	2022	2023	2024	2025
Forecasted sales	Operating Income/Loss				
Pre-investment	188,605.14 €	296,960.67 €	426,987.32 €	583,019.29 €	770,257.66 €
After the investment	200,541.08 €	318,451.81 €	459,944.68 €	629,736.13 €	833,485.87 €
Difference	11,935.95 €	21,491.14 €	32,957.36 €	46,716.84 €	63,228.20 €
Difference, %	6.3%	7.2%	7.7%	8.0%	8.2%

Figure 17. Operating income comparison for the forecasted sales

Moreover, the robot utilization can increase the unit contribution margin of bracket by three percent (Figure 18) and the unit contribution margin of sheet by seventeen percent (Figure 19).

Manufacture of vertical brackets		
	Pre-Investment	**After the Investment**
Sales price per unit	1,250.00 €	1,250.00 €
Less: Variable costs per unit	723.26 €	686.90 €
Manufacturing costs	709.10 €	672.74 €
Selling and administrative	14.16 €	14.16 €
Contribution margin	**526.74 €**	**563.10 €**
Contribution margin ratio	**42%**	**45%**

Figure 18. Variable costs per unit of bracket and contribution margin (pre-investment and after the investment)

Manufacture of concrete fiber sheet		
	Pre-Investment	After the Investment
Sales price per unit	85.00 €	85.00 €
Less: Variable costs per unit	69.17 €	57.16 €
Manufacturing costs	55.01 €	43.00 €
Selling and administrative	14.16 €	14.16 €
Contribution margin	**15.83 €**	**27.84 €**
Contribution margin ratio	**19%**	**33%**

Figure 19. Variable costs per unit of sheet and contribution margin (pre-investment and after the investment)

Furthermore, the robot implementation could increase production with more output by 100 percent in terms of brackets and by 165 percent in terms of sheets (Figure 20), and consequently lower variable unit costs by five percent in terms of brackets (Figure 18) and by seventeen percent in terms of sheets (Figure 19).

	Manual		Robot solution	
	brackets	sheets	brackets	sheets
Hours required for production of one unit	3	0.5	3	0.13
Units assemblied by 1 worker per workday	2.3	not applied	2.3	not applied
Units cut by 2 workers per workday	not applied	28	not applied	not applied
Units produced by robot per workday	not applied	not applied	not applied	64
Production at full capacity by 4 workers, units per year	1003	6104	2006	16192
Total time needed for bracket production, hours	3.5		3.13	
Difference in time for bracket production, %			11%	
Difference in terms of productivity, %			100%	165%

Figure 20. Productivity comparison manual vs robot

Besides, robot implementation enables to reduce the number of workers by 50 percent which besides financial gain in terms of decreased direct labor costs, would be beneficial for the management since less people usually easier to manage. In addition, the robot utilization allows to reduce lead time by 11 percent (Figure 20). And finally, the investment appraisal shows positive results (Figure 21).

	For the sales equal to 2019	For the forecasted sales
Payback	4.1	2.7
ARR	16%	56%
NPV	12,277.75 €	162,156.13 €

Figure 21. Key findings of investment analysis

IQ 4. What investment decision can be made based on the results from IQs 1-3?

Results of the performed data analysis show that investment in the industrial robot at the case company is worthwhile of undertaking. Besides the major nonfinancial benefits, such as healthier working environment and ease of employees' tasks, and improved product quality there are number of financial gains, such as direct labor cost reduction, improved productivity, and higher profitability. Although, payback period 2.7 – 4.1 years is not extremely short, compared to the typical payback 6 – 18 months (RobotWorx 2020), it is however, shorter than the robot's useful life – five years and therefore, the investment can be undertaken.

Accounting rate of return 16 – 56 percent is satisfactory since the company required rate of return is 12 percent (Company X representative 14 October 2019).

Net Present Value looks relatively small if considering the sales equal to 2019, however it is higher with the increasing sales as shown in the calculation of the NPV for the forecasted sales in paragraph 4.3.4. Overall, since NPV is positive, it means the case company will make profit on this investment and hence, the investment can be justified.

Based on the data, obtained from the investigative questions, the research question: **Under what conditions is capital investment in the industrial robot viable at the case company?** – can be answered as follows: if the company maintains the sales equal to 2019 or higher along with the current unit contribution margin or higher, and current fixed costs, the investment in the industrial robot can be justified.

5.2 Recommendations

The major recommendation to the case company is to carefully choose the right time for undertaking the investment. Moreover, as a student, the author recommends the company to review all the figures and validate the obtained results of this thesis with financial professionals before undertaking the investment.

5.3 Further Research

As further research the analysis of the investment could include consideration of the financing of the investment and how different types of financing would affect the profitability and return on investment.

5.4 Reliability and Validity

To ensure the validity and reliability of the thesis, all primary data was collected from the original and reliable sources. Data for the financial statement analysis is obtained from the case company's representative. Qualitative data collection methods were performed carefully. All the findings from different analysis methods support to each other and do not appear to be controversial. However, investment appraisal is based on the prediction of the company's future sales for five years, and therefore, in practice the results can differ from the outcome of this thesis.

5.5 Reflection on Learning

Working on this thesis helped the author to revise and deepen her professional knowledge of capital investment analysis and financial management along. The theoretical part included reviewing literature on the studied subject which were further applied in practice for the data analysis. It gave the author overall overview how theories and analysis methods are applied in real business cases supporting the case company in making important strategic business decision.

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Attachments

Attachment 1. Interview Questions

1. Could you shortly introduce your company?
2. Why are you considering acquiring the robot?
3. Could you describe a current production process?
4. How would the robot change the production process?
5. What are your doubts towards the investment in the robot?
6. What is the company's current financial situation?
7. What are your predictions towards the company's future growth?
8. What are the unit price of your products and the production costs?
9. What is the robot acquisition cost?
10. What is the company's required rate of return?
11. How do you plan to finance the investment?
12. What are the results do you expect from this thesis?
13. What are your preferences regarding of disclosing the company's name and company's commercial data?